



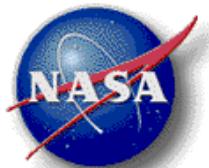
# Delay Tolerant Networking on NASA's Space Communication and Navigation Testbed

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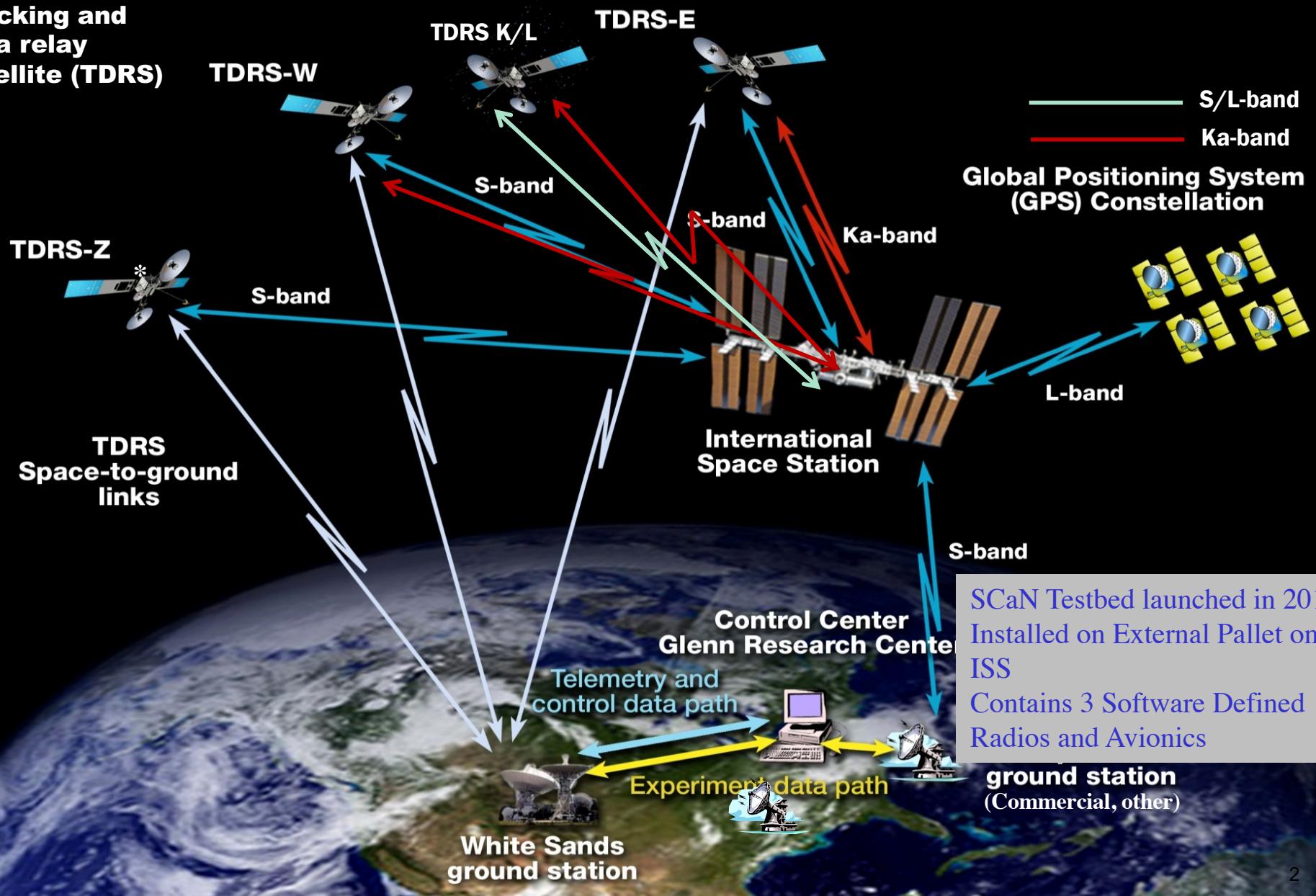
CCSDS DTN Working Group

October 2016



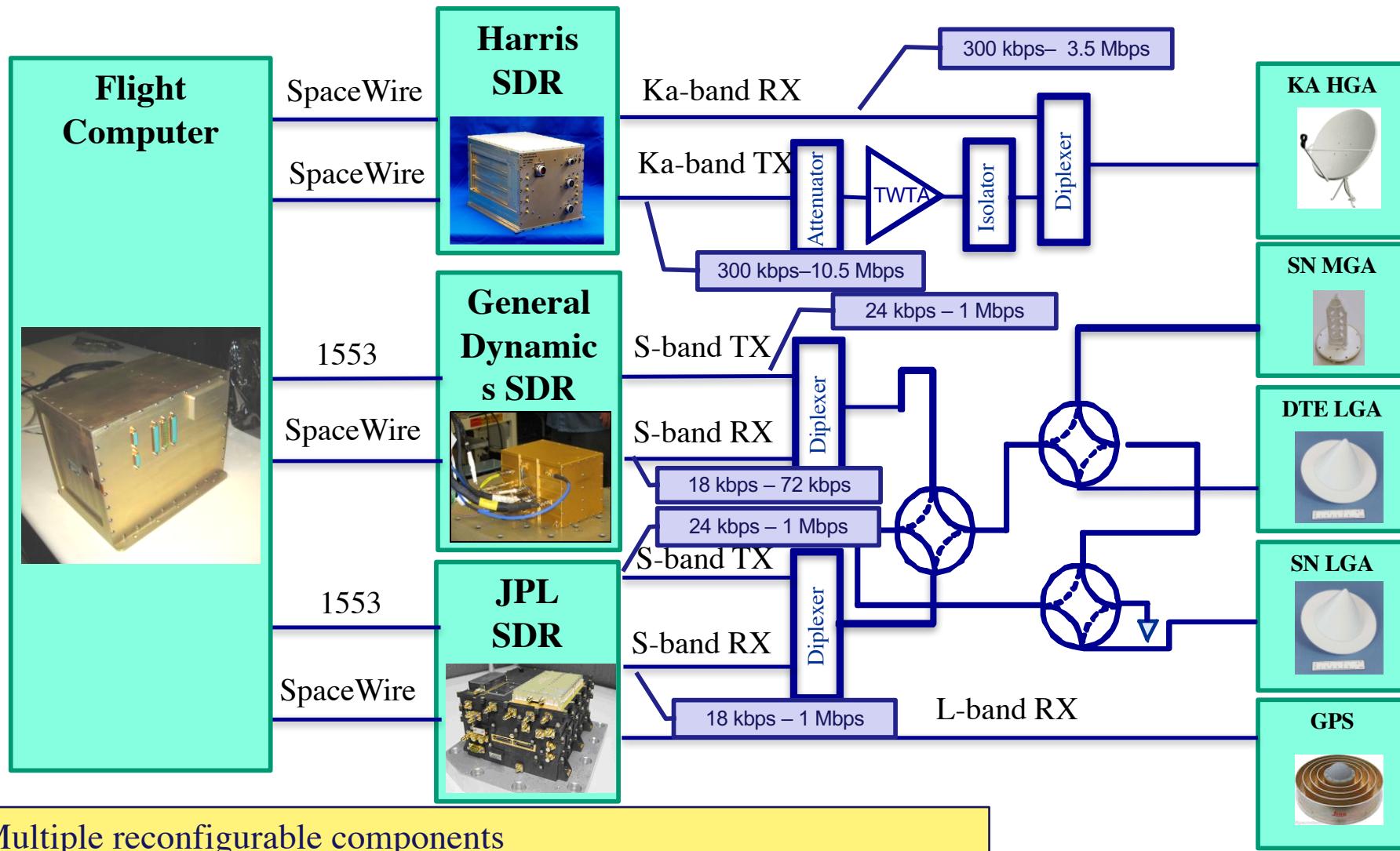
# SCAN Testbed System Architecture

**Tracking and data relay satellite (TDRS)**





# SCAN Testbed Flight System



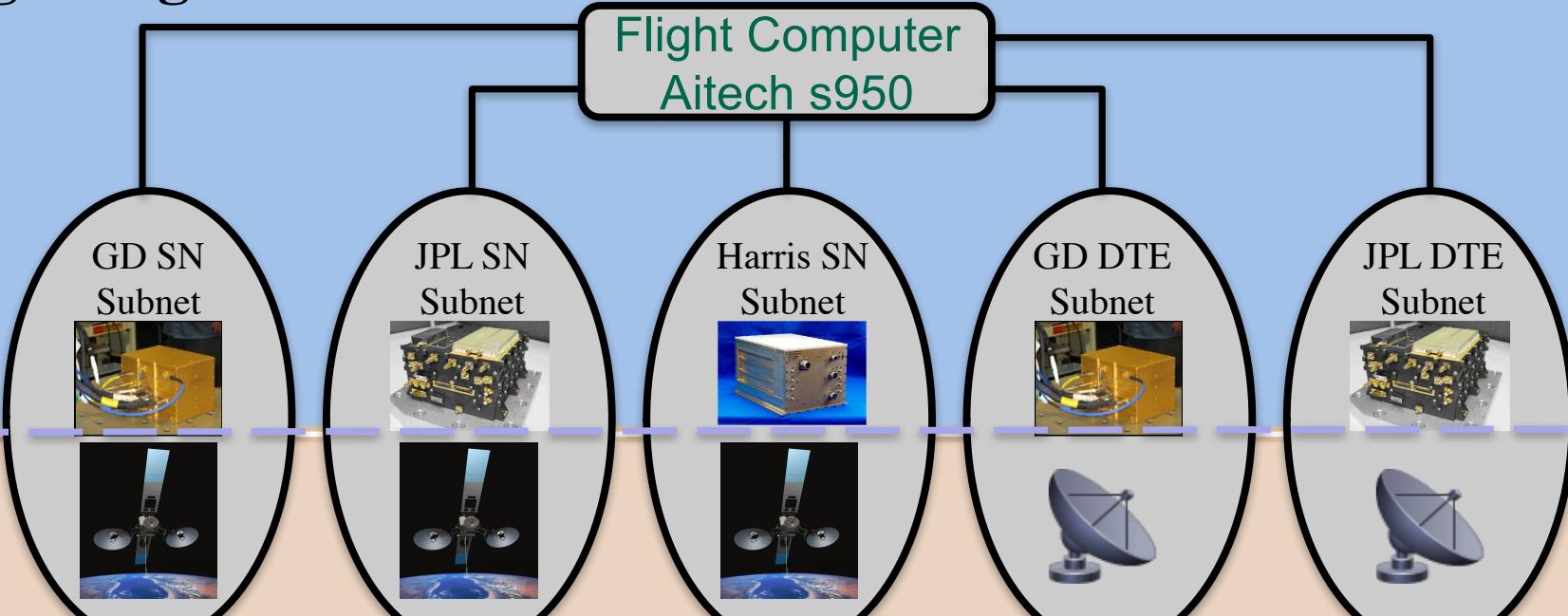
Multiple reconfigurable components

Capable of 3 simultaneous links (combination of S- and Ka-band)



# Point to Point Link Overview

## Flight Segment



## Ground Segment



# Implementation Summary

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## Space Platform

- Aitech s950
- Operating System: VxWorks 6.3
- 733 MHz
- 64 GB of flash memory



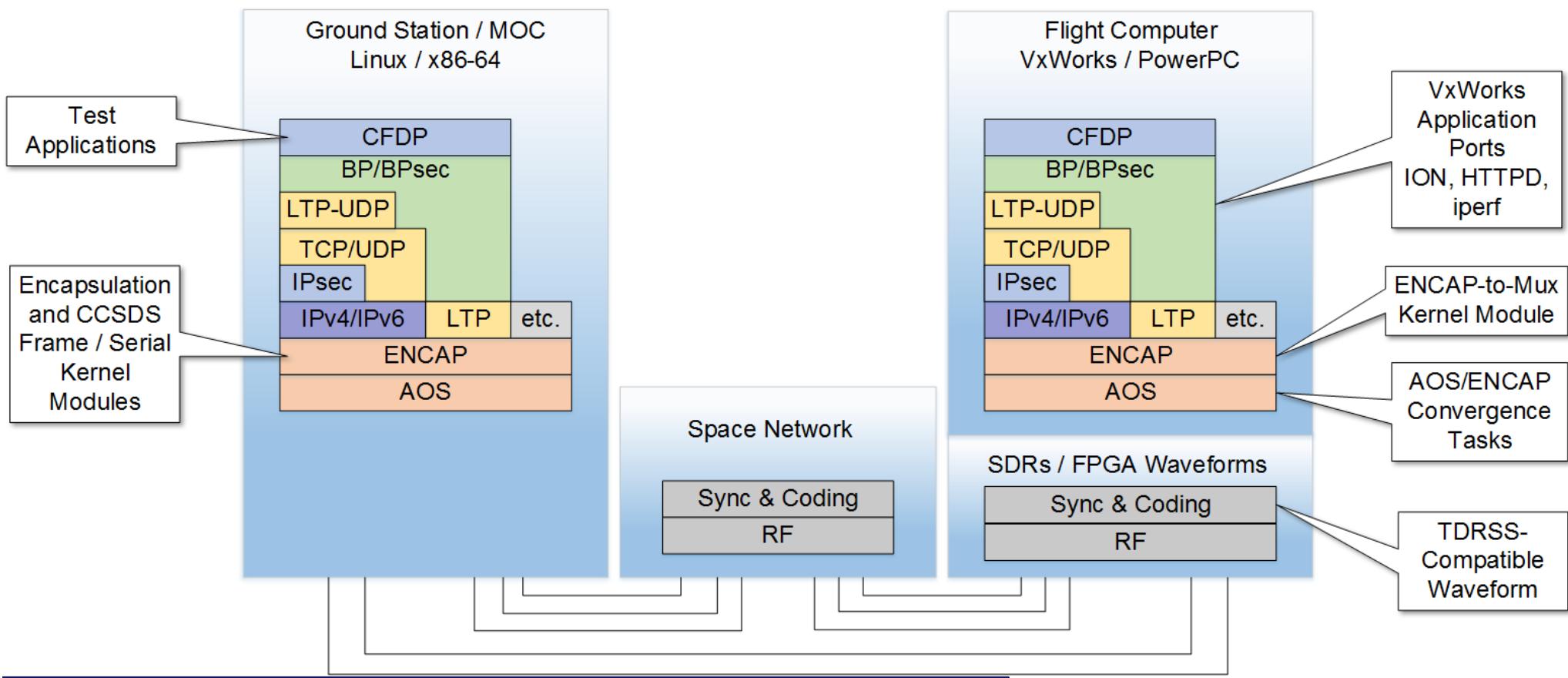
## DTN

- ION 3.3.1 + Bpsec + Network Management patches
- Some bugs found. Contributed back to open source
- Used IPN endpoint IDs
- Static routing and CGR
- Applications: bping/bpecho, CFDP
- Convergence Layers: IPsec/IPMEIR, TCP, UDP, LTP/UDP, and LTP/ENCAP

Flight-spare  
Avionics Unit



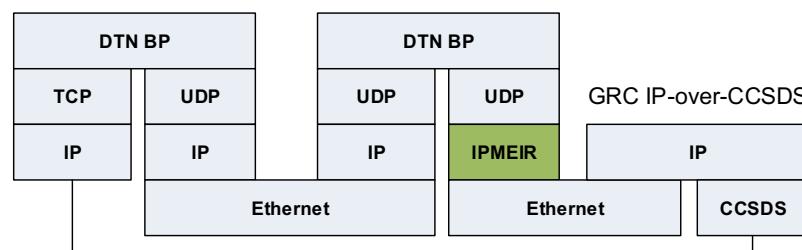
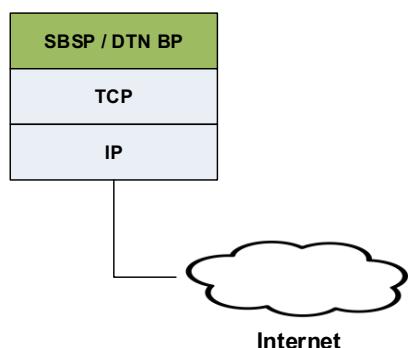
# Protocol Stack Design and Reuseable Software Components



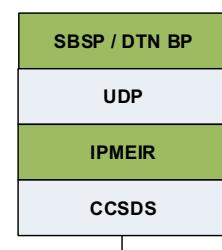


# Network Security

- SBIR Phase 2 added NSA Suite-B crypto and combination of bundle and IP-layer security to DTN / ION
- Completed successful on-orbit testing on SCaN Testbed in June of features in **green** in diagram below
  - End-to-end security at the DTN bundle layer using new Streamlined Bundle Security Protocol (SBSP)
  - Hop-by-hop security using the NSA IP security standard (IPMEIR)



GRC IP-over-CCSDS





# Space Protocol Research on the SCaN Testbed

## Application

**CCSDS 734.2-R-3**  
**CCSDS Bundle Protocol Specification**

**Network Management Protocol**  
**Key Distribution Protocol**  
**Bundle Protocol Security (BPsec)**

## Transport

**CCSDS 727.0-B-4**  
**CCSDS File Delivery Protocol**

**CCSDS 734.1-B-1**  
**(LTP)**

## Network

**CCSDS 702.1-B-1**  
**IP over CCSDS Space Links**

**CCSDS 133.1-B-2**  
**Encapsulation Service**

## Data Link

**CCSDS 131.0-B-2**  
**TM Synchronization and Channel Coding**

**CCSDS 732.0-B-2 AOS Space Data Link Protocol**

## Physical

**CCSDS 131.3-B-1 CCSDS Space Link Protocols over ETSI DVB-S2 Standard.**

**CCSDS 131.5-M-1 Variable Coded Modulation Protocol**

**CCSDS 401.0-B-25**  
**RF Earth Stations and Spacecraft**

**CCSDS 415.1-B01**  
**Data Transmission and PN Ranging for 2 GHz Link via Data Relay Satellite**

## Cross Support SLE

**CCSDS 911.1-B-3** *Space Link Extension—Return All Frames*

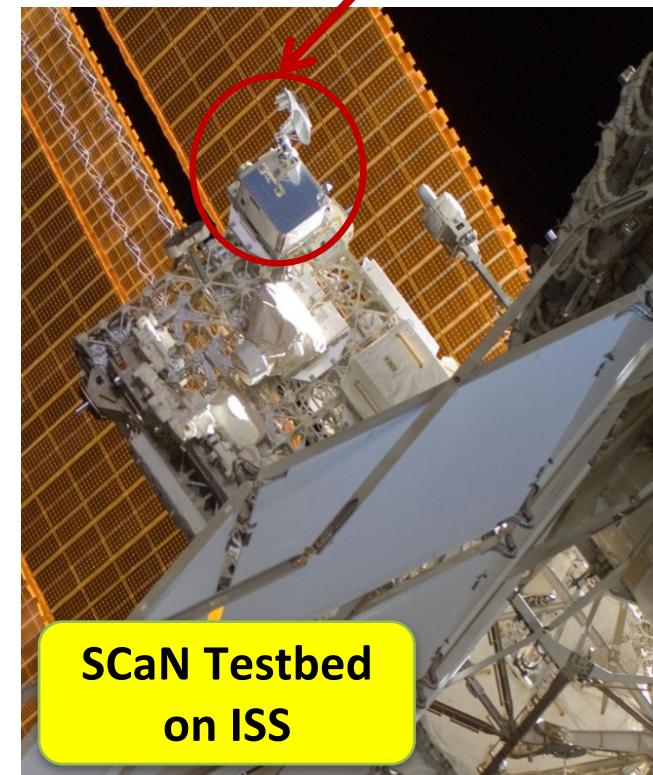
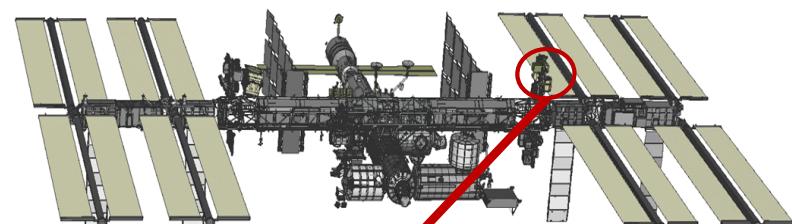
**CCSDS 911.2-B-2**

**CCSDS 911.5-B-2**

**CCSDS 912.11-0-1** *SLE—Enhanced Forward CLTU*

**CCSDS 912.1-B-3** *SLE—Forward CLTU Svc*

**CCSDS 913.1-B-1** *SLE – IP for Transfer Svc*



**SCaN Testbed  
on ISS**